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In re Application of:	)	
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Masayoshi OKURA, et al.	)	**BOX AF**
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Application No.: 09/613,742	)	Group Art Unit: 2872
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Filed: July 11, 2000	)	Examiner: J. PHAN
	)	
For: ROTARY DEFLECTOR, OPTICAL SCANNING UNIT AND IMAGE FORMING APPARATUS	)))	

Commissioner for Patents
BOX AF
Washington, DC 20231

Sir:

VERIFICATION OF A TRANSLATION

I, the below named translator, hereby declare that:

My name and post office address are as stated below;

That I am knowledgeable in the English language and in the Japanese language and believe the attached English translation to be a true and complete translation of the below identified document.

The documents for which the attached English translation is being submitted are the Japanese Patent Application No. 11-255592, filed in Japan on September 9, 1999. This Japanese language document was filed in the United States Patent and Trademark Office on July 11, 2000.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are

punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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[Designation of Document] Specification

[Title of the Invention] Rotary Deflector, Optical Scanning Unit and Image Forming Apparatus

[Claims]

[Claim 1] A rotary deflector wherein a mass member is attached to a non-driving section of a driving motor for rotating a polygon mirror.

[Claim 2] The rotary deflector according to Claim 1, wherein the non-driving section is a stationary shaft located at the center of rotation of the driving motor and the mass member is attached to the stationary shaft.

[Claim 3] The rotary deflector according to Claim 2, wherein the center of gravity of the mass member is located almost at the center of axis of the stationary shaft.

[Claim 4] The rotary deflector according to Claim 2 or 3, wherein the mass member is a plate-like member and is symmetrical about the center of gravity.

[Claim 5] The rotary deflector according to any one of Claims 2 to 4, wherein the mass member of a size of reducing vibration within the range of rotational speed of the driving motor is added.

[Claim 6] The rotary deflector according to Claim 5, wherein the weight of the mass member is 5g or more.

[Claim 7] The rotary deflector according to any one of Claims 2 to 6, characterized by including:

an engaging section formed at the upper part of the stationary shaft;

an engaged section which is formed at the center of gravity of the mass member and which engages with the engaging section, and

fixing unit for fixing the engaged section and the engaging section.

[Claim 8] The rotary deflector according to any one of Claims 2 to 6, wherein the mass member is formed in a body with the stationary shaft.

[Claim 9] An optical scanning unit provided with a rotary deflector according to any one of Claims 1 to 8.

[Claim 10] The optical scanning unit according to Claim 9, wherein a stopper for blocking the mass member from turning more than a predetermined value is provided within a housing for storing the rotary deflector.

[Claim 11] The optical scanning unit according to Claim 9, wherein an elastic member which contacts with the mass member and blocks it from turning is provided within the housing for storing the rotary deflector.

[Claim 12] An image forming apparatus having an optical scanning unit according to any one of Claims 9 to 11.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to a rotary deflector, an optical scanning unit and an image forming apparatus for use in a laser printer, a digital copier and the like.

[0002]

[Prior Art]

An optical scanning unit is provided with a driving motor for rotating a polygon mirror at high speed. However, it is unable to realize a high image quality because optical parts vibrate, scanning position deviates periodically and nonuniformity of pitch occurs on an image unless vibration caused by the driving motor is reduced. Still more, noise may be generated when a housing of the optical scanning unit resonates with a base of the image forming apparatus.

[0003]

In order to eliminate such a problem, JP-A-5-264916 has disclosed a method of controlling the resonating condition of the housing by changing fixing points of the base and the housing of the image forming apparatus per type of machine or by increasing/reducing a mass element to be added to the housing, to avoid the resonance frequency of the housing in correspondence to changes of vibrating frequency of a source of vibration.

[0004]

However, there has been a problem that when the fixing points of the housing are changed, the position of a laser beam

fluctuates and the image quality degrades because the amount and the mode of deformation of the housing change.

[0005]

The driving motor for rotating the polygon mirror is arranged so as to switch the rotational speed during the standby state and the image forming time to reduce power consumption and to switch the rotational speed corresponding to an image density in order to accommodate to plural image densities (resolutions).

[0006]

However, because the above-mentioned prior arts have had no arrangement of reducing the vibration of the vibrating source itself, there has been a problem that when the rotational speed is changed, the vibrating frequency of the driving motor approaches the vibrating frequency of the housing, thus resonating and causing noise.

[0007]

[Problems that the Invention is to Solve]

The present invention has been made in order to solve the above-mentioned problem and reduces noises and stabilizes the image quality by reducing vibration of the image forming apparatus by reducing vibration of the driving source itself within a preset frequency range without changing the resonating condition of the housing.

[0008]

[Means for solving the Problems]

According to an invention described in Claim 1, a mass member is added to a non-driving section of a driving motor for rotating a polygon mirror. It then becomes possible to avoid the resonation and to reduce vibration and noise by moving a resonance point by adding the mass member to the non-driving section.

[0009]

For instance, it is possible to reduce the vibration by attaching the mass member to a stationary shaft which is located at the center of rotation of the driving motor and which is considered to be the non-driving section.

[0010]

[Mode for Carrying Out the Invention]

An optical scanning unit provided with a rotary deflector of a first embodiment will be explained below with reference to the drawings.

(Schematic Structure of Optical Scanning Unit)

As shown in Figs. 1 through 4, a housing 16 of the optical scanning unit 14 is formed of synthetic resin and is attached to a base 18 of an image forming apparatus by four fixing screws 12. The fixing points of the fixing screws 12 are always fixed and are not shifted depending on types of machine. Therefore, the amount and the mode of deformation of the housing 16 restricted by the fixing screws 12 are uniform and the position

of the laser beam does not fluctuate per type of machine, thus causing no degradation of image quality.

[0011]

An upper opening of the housing 16 is almost closed by a cover (not shown) and optical parts are stored in the concealed space.

[0012]

In the optical system comprising such optical parts, a laser beam emitted out of a laser diode 10 is collimated by a collimator lens 18, is shaped by a slit 20, is reflected by a reflecting mirror 22 and arrives at a polygon mirror 24 composing a rotary deflector 31 via Fθ lenses 26 and 28. The polygon mirror 24 is a polygonal column having plural mirrors on the side faces thereof and is rotated at high speed by a driving motor 30.

[0013]

The laser beam obtains a swing angle by being deflected by the polygon mirror 24, passes through the Fθ lenses 26 and 28 again and is reflected by a mirror 34 and a cylindrical mirror 200 to be scanned on a photoreceptor (not shown).

[0014]

It is noted that a quantity of emission and emitting time of the laser diode 10 are controlled by a laser diode driver substrate. The laser diode 10 corresponding to image signals from the main body side is modulated to record an image on the

photoreceptor.

[0015]

Further, an SOS sensor 32 receives the laser beam reflected by a pickup mirror 36 disposed at the position before the image forming area of the photoreceptor to which the laser beam is irradiated at first, to take image writing timing.

[0016]

Next, the rotary deflector will be explained.

[0017]

As shown in FIG 3, a base plate 38 of the driving motor 30 provided in the rotary deflector 31 is fixed to the bottom of the housing 16 by fixing screws 40. A cylindrical stationary shaft 44 is fitted into a concave 42 formed at the center of the base plate 38 so as to stand straight.

[0018]

A long screw 46 is inserted into a through hole of the stationary shaft 44 from the top. The long screw 46 penetrates through the concave 42 and is screwed into a nut 50 fitted from the back of the base plate 38. Thereby, the stationary shaft 44 is fixed to the base plate 38 so as to stand straight from the top and bottom between the head 48 of the long screw 46 and the concave 42 via a washer 52.

[0019]

A rotary sleeve 54 whose inner diameter is slightly larger than the outer diameter of the stationary shaft 44 is

inserted into the stationary shaft 44 so as to be turnable centering on the stationary shaft 44. It is noted that multiple dynamic pressure generating grooves (not shown) which are aslant with respect to the axial direction by a certain angle are grooved on the outer peripheral face of the stationary shaft 44.

[0020]

A flange 56 is attached to the rotary sleeve 54 and the polygon mirror 24 is attached to the flange 56 coaxially with the rotary sleeve 54.

[0021]

The flange 56 is provided with a thrust bearing magnet 58 and a driving magnet 60. A magnetic material 62 is disposed on the base plate 38 so as to face to the side of the thrust bearing magnet 58 so that the rotary sleeve 54 does not move up and down by its magnetic action. A driving coil 64 is disposed on the base plate 38 to rotate the polygon mirror 24 at predetermined rotational speed by generating repulsive force and attractive force between the driving magnet 60 and the driving coil 64 by supplying alternating current whose phase is shifted.

[0022]

Meanwhile, a screw hole 66 is formed at the axial center of the head 48 of the long screw 46 so as to be able to screw in a fixing screw 68. A step 70 is formed around the periphery

of the head 48 so as to support a mass member 72 when an attaching hole 74 formed at the center of gravity of the mass member 72 is inserted into the head 48. That is, the mass member 72 may be fixed to the head 48 of the stationary shaft 44 by the fixing screw 68 via a washer 76 and a spring washer 77 without disassembling the stationary shaft 44. Therefore, it is possible to attach/remove easily the mass member having different mass in correspondence to fluctuation of vibrating frequency and to realize a low noise and high image quality image forming apparatus by suppressing the vibration of the base 18 in a target frequency range.

[0023]

The mass member 72 is formed of a square iron plate so as to be able to obtain the necessary mass with a small volume. The mass member 72 is symmetrical centering on the center of gravity thereof and its deflection from the center of gravity is constant. Also, the stationary shaft 44 will not fall when the mass member 72 is attached to the stationary shaft 44, by causing the center of gravity of the mass member 72 to almost coincide with the center of axis of the stationary shaft 44.

[0024]

Fig. 5 shows the relationship between the vibration level of the base 18 and noise when the optical scanning unit 14 in which the mass member 72 (mass: 50 g) is attached to the stationary shaft 44 is mounted on the base 18 of the image

forming apparatus. Here, the value of vibration (mV) is what acceleration is transformed into voltage and 1000 mV = 9.8 m/s^2 (acceleration).

[0025]

While the vibration of the base 18 is caused as exciting force caused by unbalance of the driving motor 30 is transmitted thereto via the housing 16 of the optical scanning unit 14, the sound pressure level may be lowered to 52 dB or less and noise may be reduced by reducing the value of vibration to 50 mV or less.

[0026]

It is thus possible to reduce the level of vibration and to reduce the noise by avoiding the resonation by moving the resonance point by adding the mass member 72 to the stationary shaft 44 of the driving motor 30 in the present embodiment.

[0027]

Figs. 6 and 7 show the result of comparison of vibration levels in the case where the mass member 72 is not attached and in the case where it is attached. The vibration in the vertical direction (the thrust direction of the stationary shaft 44) was measured at the fixing section of the base plate 38 of the rotary deflector 31 as the measuring point.

[0028]

Then, the vibration level was measured by changing the rotational speed of the driving motor 30 from 250 Hz to 400

Hz. As a result, while the vibration level was 300 mV when there was no mass member as shown in Fig. 6 when the rotational speed was 340 Hz in forming an image as shown in Fig. 7, it was reduced to 65 mV when the mass member was attached. Thus, it was possible to prevent noise from occurring in switching the speed of the rotary deflector.

[0029]

The image forming apparatus of the present embodiment is a printer which is capable of accommodating with two kinds of resolution of 600 DPI and 480 DPI. The rotational speed of the polygon mirror 24 in printing in 600 DPI is 340 turns/second and the rotational speed of the polygon mirror 24 in printing in 480 DPI is 272 turns/second. Graphs in Figs. 8 and 9 show the result in the range of rotational speed in use (272 Hz to 340 Hz). When the vibration at the center of the housing 16 was measured, the vibration level was reduced to 10 mV when the mass member was attached as compared to the case of 60 mV in maximum when no mass member was attached.

[0030]

Figs. 10 and 11 show the comparison of vibration levels of the base 18. The measuring point was the center of four fixing points where the housing 16 shown in Fig. 1 is fixed by the fixing screws 12. While the vibration level was 340 mV in maximum when no mass member was attached, it was reduced to 20 mV when the mass member was attached.

[0031]

The unbalance of the driving motor 30 used in the rotary deflector of the present embodiment has a specification of G2 (JISB0905: grade of balance of rotary device).

[0032]

The measured results shown in Figs. 5 through 11 are what the unbalance of the driving motor 30 was confirmed on the level of G2. Graphs in Figs. 12 and 13 show the result when the vibration of the base 18 was measured by increasing the degree of unbalance of the driving motor 30 intentionally to G6.

[0033]

According to this measured result, while the vibration level was 680 mV in maximum when no mass was attached, it was reduced to 20 mV or less when the mass member was attached and the unbalance was reduced to the vibration level of G2. Thus, the vibration does not change due to a drift of balance, so that it is possible to realize low vibration design in a short time, improving the reliability.

[0034]

Although most of the unbalance of the driving motor of mass-produced products is normally controlled in the levels of G1 through G3, it is possible to considerably relax balance specifications, to reduce balancing processes and to reduce the cost considerably by attaching the mass member even when the grade of G is low.

[0035]

Next, the relationship between the mass of the mass member and the resonance frequency will be explained.

[0036]

The resonance point moves downward stepwise, as shown in Fig. 14(A) in which the resonance point is 400 Hz when no mass member is attached, in Fig. 14(B) in which the resonance point is 220 Hz when the mass member is 25 g, in Fig. 14(C) in which the resonance point is 155 Hz when the mass member is 50 g, in Fig. 14(D) in which the resonance point is 140 Hz when the mass member is 65 g, in Fig. 14(E) in which the resonance point is 130 Hz when the mass member is 75 g, and in 14(F) in which the resonance point is 110 Hz when the mass member is 85 g.

[0037]

Thus, it becomes possible to tune optimally to lower the vibration per type of machine and to readily accommodate to other type machines just by selecting the mass of the mass member.

[0038]

Figs. 15 and 16 show a rotary deflector of a second embodiment.

[0039]

A mass member 80 is formed of a rectangular iron plate. An attaching hole 82 formed at the center of gravity of the

plate is inserted into the head 48 of the long screw 46 and is fixed by the fixing screw 68. Hook pieces 80A are bent downward at the both ends of the mass member 80 in the longitudinal direction and are positioned between ribs 84 for reinforcing the housing 16. Even if the fixing screw 68 for fixing the mass member 80 becomes loose due to vibration, the ribs 84 intervene the hook pieces 80A to stop the rotation of the mass member 80 structurally.

[0040]

It is noted that while a spring washer 77 is used as a measure for preventing the fixing screw 68 from being loosened, a hook piece 80A is also provided so that it hits against a rib 84 and stops rotation of the mass member, thus damaging no other optical parts, even when it so happens that the mass member 80 is loosened while shipping the image forming apparatus. Further, because the degree of rotation before hitting against the rib 84 is very small and the pressure of the spring washer 77 is fully strong, it is possible to keep the stable state unless an abnormality occurs.

[0041]

When the mass member 80 of 75 g is attached to a copier whose resolution is 600 DPI, rotational speed of the rotary deflector is 340 rps and rotational speed during the standby state is 170 rps, it is possible to reduce vibration of 170 Hz to 340 Hz.

[0042]

Next, the relationship between the weight balance of the mass member and the vibration level of the base will be explained.

[0043]

In a mass member 86 shown in Fig. 17, the ratio of weight of an area (hatched part) of 35 mm x 35 mm centering on an attachment hole 88 to the whole mass of 75 g is set at 33 %. In a mass member 90 shown in Fig. 18, a thin plate 90B is pasted at the center part to set the ratio of weight of the area of 35 mm x 35 mm centering on the attachment hole 88 to the whole mass of 75 g at 46 %.

[0044]

In a mass member 92 shown in Fig. 19, a plate member 92B is pasted at the center part to set the ratio of weight of the area of 35 mm x 35 mm centering on the attachment hole 88 to the whole mass of 75 g at 57 %. In a mass member 94 shown in Figs. 20 and 21, a thick plate 96 is pasted at the center part to set the ratio of weight of the area of 35 mm x 35 mm centering on the attachment hole 88 to the whole mass of 75 g at 66 % to concentrate the weight further.

[0045]

It is thus possible to reduce the vibration level of the base 18 by concentrating the ratio of weight of the mass member on the axial center of the stationary shaft as it may be judged

from a graph shown in Fig. 22. It is noted that this experimental result shows maximum values in the use rotational frequency range of 170 Hz to 340 Hz and the vibration level is stabilized by concentrating the weight ratio to 46 % or more. However, when the weight ratio is concentrated up to 57 %, no problem occurs even when there is dispersion (3 % in maximum) due to mass-production. It is noted that the mass members 86, 90, 92 and 94 are provided with hook pieces 86A, 90A, 92A and 94A whose rotation is stopped by the rib 84 of the housing 16.

[0046]

Fig. 23 shows the relationship between the mass of the mass member and the resonance point.

[0047]

As it is apparent from Fig. 23, the dispersion of the resonance point of the base 18 is reduced to 20 Hz or less and the effect of the present invention may be brought about by increasing the mass of the mass member to 5 g or more.

[0048]

Fig. 24 shows the relationship between the gravitational position of the mass member acting in the axial direction of the driving motor and the resonance frequency of the base. As shown in the graph, the gravitational position of the mass member is also one of important parameters deciding the resonance point.

[0049]

Next, a rotary deflector of a third embodiment will be explained.

[0050]

As shown in Figs. 25 and 26, a sheet-like foaming sponge 98 is pasted as an elastic member on the both faces of the inside of the rib 84 and the hook piece 80A of the mass member 80 is positioned in the foaming sponge 98. It has been confirmed that when the hook piece 80A is pressed lightly or strongly against the foaming sponge 98 as shown in Fig. 27, no sound of chatter occurs as shown in a graph in Fig. 28. Thus, the inclusion of the foaming sponge 98 allows prevention of such sound of chatter that may occur when without foaming sponge 98 the hook piece 80A contacts with the rib 84.

[0051]

Next, a rotary deflector of a fourth embodiment will be explained.

[0052]

According to the fourth embodiment, a disk-like mass member 104 is formed in a body with a stationary shaft 102 at the upper part thereof as shown in FIGs 29 and 30. A long screw 100 is inserted through a penetrating section of the stationary shaft 102 and is fastened to a nut 50 by turning a head 106 thereof by a driver.

[0053]

Thus, the rigidity of the stationary shaft increases and

it becomes advantageous from the aspect of attaching space and production cost by forming the stationary shaft in a body with the mass member.

[0054]

It is noted that although the housing has been made of synthetic resin in the embodiments described above, the vibration may be reduced further when the housing is made of aluminum whose rigidity is higher.

[0055]

[Advantage of the Invention]

As described above, the invention allows the low noise and high image quality image forming apparatus to be realized by suppressing the vibration of the base in the target frequency range without deforming the housing. It also allows to prevent noise from occurring in switching the speed of the rotary deflector.

[0056]

Still more, the optical scanning units may be made common because the reduction of vibration may be optimized by the mass member. It is also possible to tune optimally to lower vibration per each type machine and to reduce the balancing processes of the driving motor considerably by selecting the mass member.

[Brief Description of the Drawings]

[Fig. 1] Fig. 1 is a plan view showing an optical

scanning unit provided with a rotary deflector according to a first embodiment;

[Fig. 2] Fig. 2 is an exploded perspective view of the rotary deflector according to the first embodiment;

[Fig. 3] Fig. 3 is a section view of the rotary deflector according to the first embodiment;

[Fig. 4] Fig. 4 is a plan view of the rotary deflector according to the first embodiment;

[Fig. 5] Fig. 5 is a graph showing the relationship between vibration of a base and noise;

[Fig. 6] Fig. 6 is a graph showing the vibration level of a driving motor when no mass member is attached;

[Fig. 7] Fig. 7 is a graph showing the vibration level of the driving motor when the mass member is attached;

[Fig. 8] Fig. 8 is a graph showing the vibration level of the housing when no mass member is attached;

[Fig. 9] Fig. 9 is a graph showing the vibration level of the housing when the mass member is attached;

[Fig. 10] Fig. 10 is a graph showing the vibration level of the base when no mass member is attached;

[Fig. 11] Fig. 11 is a graph showing the vibration level of the base when the mass member is attached;

[Fig. 12] Fig. 12 is a graph showing the vibration level of the base when a quantity of unbalance of the driving motor is increased and no mass member is attached;

[Fig. 13] Fig. 13 is a graph showing the vibration level of the base when a quantity of unbalance of the driving motor is increased and the mass member is attached;

[Fig. 14] Fig. 14 is a graph showing the relationship between the mass of the mass member and the vibration level of the base;

[Fig. 15] Fig. 15 is a plan view of a rotary deflector according to a second embodiment;

[Fig. 16] Fig. 16 is a section view of the rotary deflector according to the second embodiment;

[Fig. 17] Fig. 17(A) is a plan view showing a modified example in which the balance of weight of the mass member is changed and Fig. 17(B) is a section view showing the modified example in which the balance of weight of the mass member is changed;

[Fig. 18] Fig. 18(A) is a plan view showing a modified example in which the balance of weight of the mass member is changed and Fig. 18(B) is a section view showing the modified example in which the balance of weight of the mass member is changed;

[Fig. 19] Fig. 19(A) is a plan view showing a modified example in which the balance of weight of the mass member is changed and Fig. 19(B) is a section view showing the modified example in which the balance of weight of the mass member is changed;

[Fig. 20] Fig. 20 is a perspective view showing the modified example in which the balance of weight of the mass member is changed;

[Fig. 21] Fig. 21(A) is a plan view showing a modified example in which the balance of weight of the mass member is changed and Fig. 21(B) is a section view showing the modified example in which the balance of weight of the mass member is changed;

[Fig. 22] Fig. 22 is a graph showing the relationship between weight balance of the mass member and the vibration level of the base;

[Fig. 23] Fig. 23 is a graph showing the relationship between the mass of the mass member and the resonance point;

[Fig. 24] Fig. 24 is a graph showing the relationship between the gravitational position of the mass member and the resonance frequency of the base;

[Fig. 25] Fig. 25 is a plan view of a rotary deflector according to a third embodiment;

[Fig. 26] Fig. 26 is a section view of the rotary deflector according to the third embodiment;

[Fig. 27] Fig. 27 is a plan view of the rotary deflector according to the third embodiment;

[Fig. 28] Fig. 28 is a graph showing the relationship between the mass member and the sound of chatter;

[Fig. 29] Fig. 29 is a plan view of the rotary deflector

according to the third embodiment; and

[Fig. 30] Fig. 30 is a section view of the rotary deflector according to the third embodiment.

[Description of the Reference Numerals and Signs]

44	STATIONARY SHAFT (NON-DRIVING SECTION)
48	HEAD (ENGAGING SECTION)
68	FIXING SCREW (FIXING MEANS)
72	MASS MEMBER
74	ATTACHING HOLE (ENGAGED SECTION)
80	MASS MEMBER
80A	HOOK PIECE
84	RIB (STOPPER)
98	FOAMING SPONGE (ELASTIC MEMBER)
102	STATIONARY SHAFT
104	MASS MEMBER

[Designation of Document] Abstract

[Abstract]

[Problem] To reduce noises and stabilize the image quality of an image forming apparatus by reducing vibration thereof by reducing vibration of a driving source itself within a preset frequency range without changing the resonating condition of a housing.

[Means for Resolution] A mass member 70 is added to a stationary shaft 44 of a driving motor 30 for rotating a polygon mirror 24. It then becomes possible to reduce the vibration and noise of an image forming apparatus by avoiding resonation by moving a resonance point by adding the mass member 70 to the stationary shaft 44. Thus, a high image quality image forming apparatus can be realized.

[Selected Drawing] FIG 3

Fig. 5:

a: TARGET VALUE: < 50 mV

b: NOISE TARGET VALUE

c: VALUE OF VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

d: SOUND PRESSURE LEVEL (dB)

Fig. 6:

a: NO MASS MEMBER

b: VIBRATION OF DRIVING MOTOR IN THRUST DIRECTION [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

Fig. 7:

a: MASS MEMBER: 50 g

b: VIBRATION OF DRIVING MOTOR IN THRUST DIRECTION [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

Fig. 8:

a: NO MASS MEMBER

b: VIBRATION OF HOUSING [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

Fig. 9:

a: MASS MEMBER: 50 g

b: VIBRATION OF HOUSING [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

Fig. 10:

a: NO MASS MEMBER

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

Fig. 11:

a: MASS MEMBER: 50 g

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

Fig. 12:

a: NO MASS MEMBER

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

Fig. 13:

a: MASS MEMBER: 50 g

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

Fig. 14(A):

a: NO MASS MEMBER

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

Fig. 14(B):

a: MASS MEMBER: 25 g

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

d: RESONANT POINT

Fig. 14(C):

a: MASS MEMBER: 50 g

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

d: RESONANT POINT

Fig. 14(D):

a: MASS MEMBER: 65 g

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

d: RESONANT POINT

Fig. 14(E):

a: MASS MEMBER: 75 g

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

d: RESONANT POINT

Fig. 14(F):

a: MASS MEMBER: 85 g

b: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

c: ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

d: RESONANT POINT

Fig. 22:

a: VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]

b: WEIGHT BALANCE OF MASS MEMBER [%]

Fig. 23:

a: RESONANT FREQUENCY OF BASE OF IMAGE FORMING APPARATUS [Hz]

b: MASS OF MASS MEMBER [g]

c: UPPER LIMIT OF DISPERSION

d: LOWER LIMIT OF DISPERSION

Fig. 24:

a: RESONANT FREQUENCY OF BASE OF IMAGE FORMING APPARATUS [Hz]

b: POSITION OF CENTER OF GRAVITY IN THE MOTOR AXIAL DIRECTION OF MASS MEMBER [mm]

Fig. 28:

a: OCCURRENCE OF SOUND OF CHATTER

b: EXIST

c: NONE

d: NON-CONTACT

e: SPONGE CONTACTS LIGHTLY

f: SPONGE CONTACTS STRONGLY

g: NO SPONGE, CONTACT WITH LIB

[Document Name] Drawing

FIG. 1

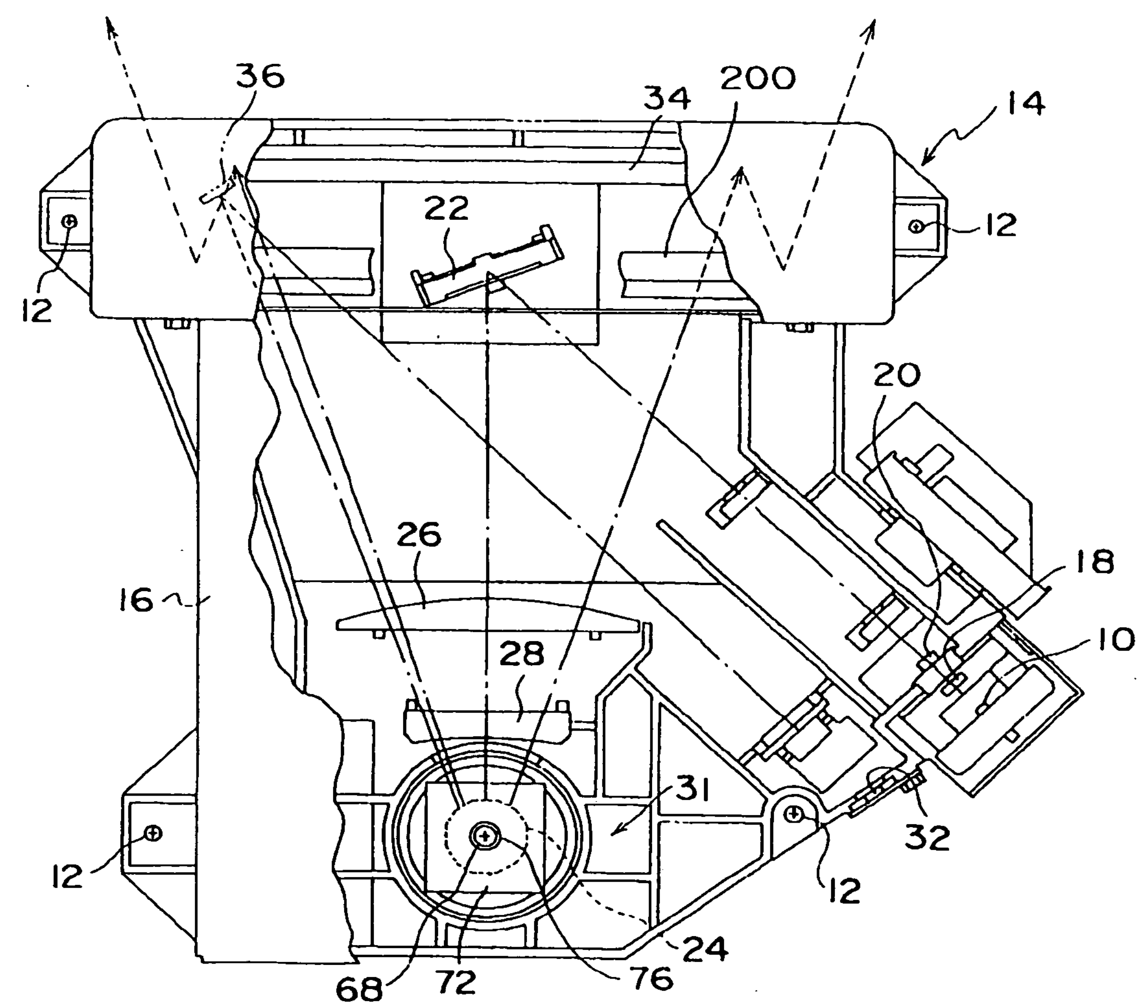


FIG. 2

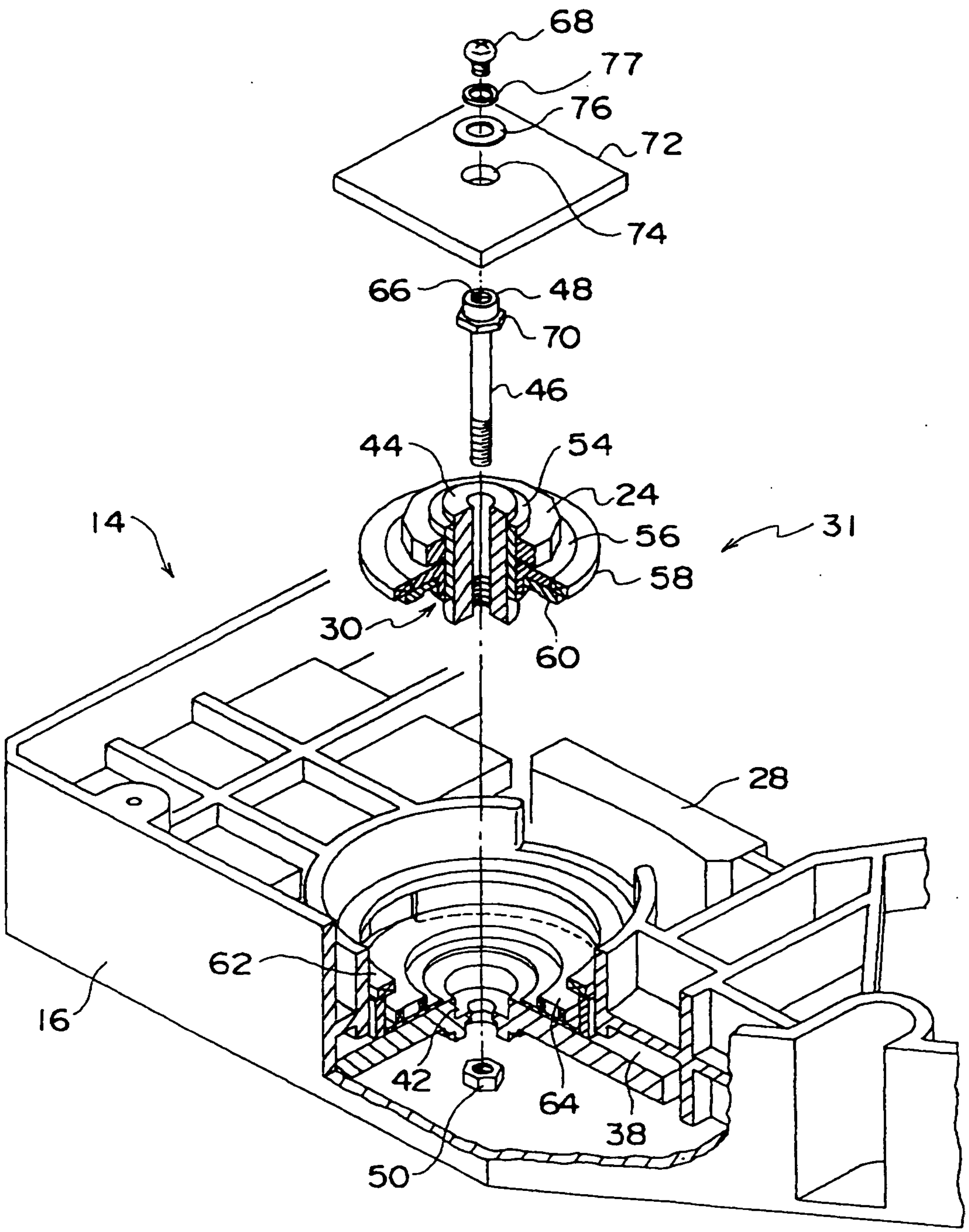

68
77
76
72
74
66
48
70
46
44
54
24
56
58
31
14
30
60
28
62
16
42
64
38
50

FIG. 3

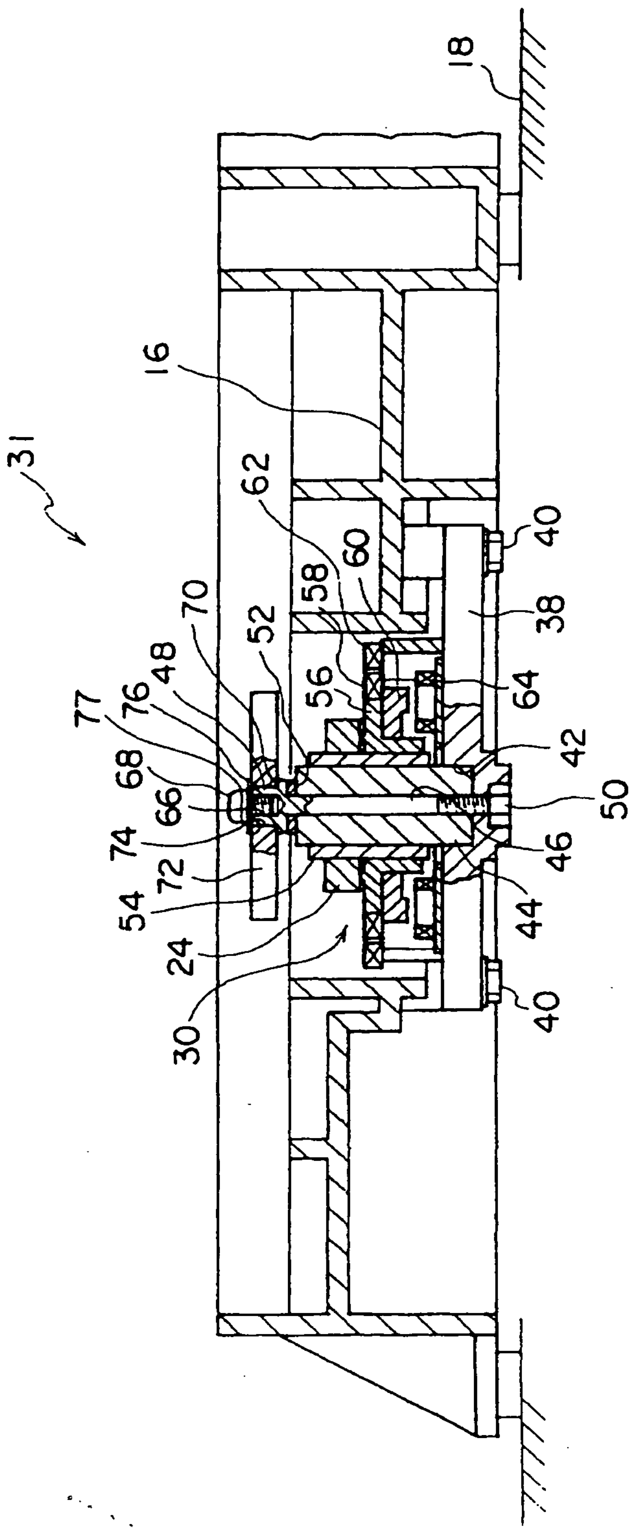

18
16
31
62
60
40
58
70
52
38
48
76
77
56
64
68
42
66
50
74
46
72
54
44
24
30
40

FIG. 4

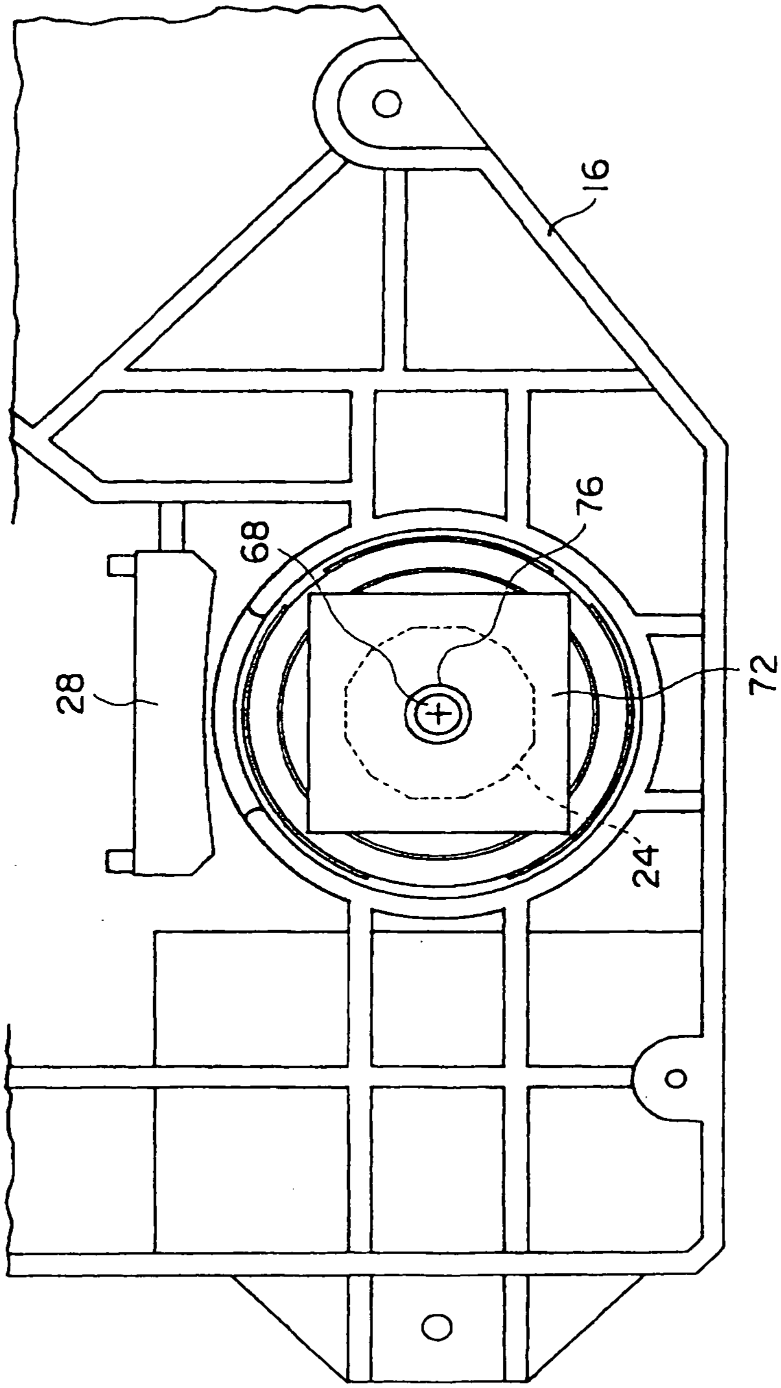


FIG. 5

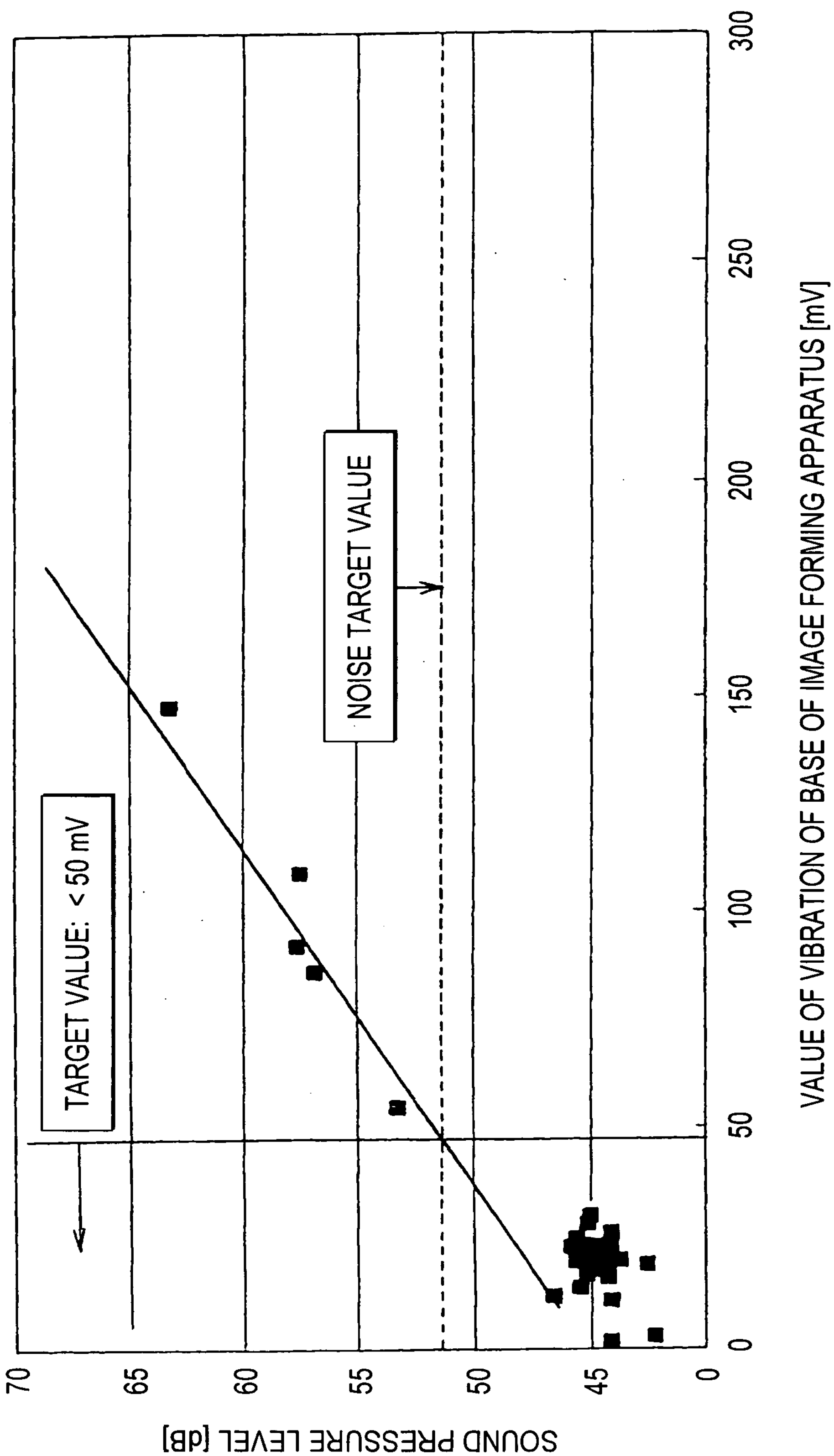

TARGET VALUE: < 50 mV
NOISE TARGET VALUE
SOUND PRESSURE LEVEL [dB]
VALUE OF VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
0
45
50
55
60
65
70
0
50
100
150
200
250
300

FIG. 6

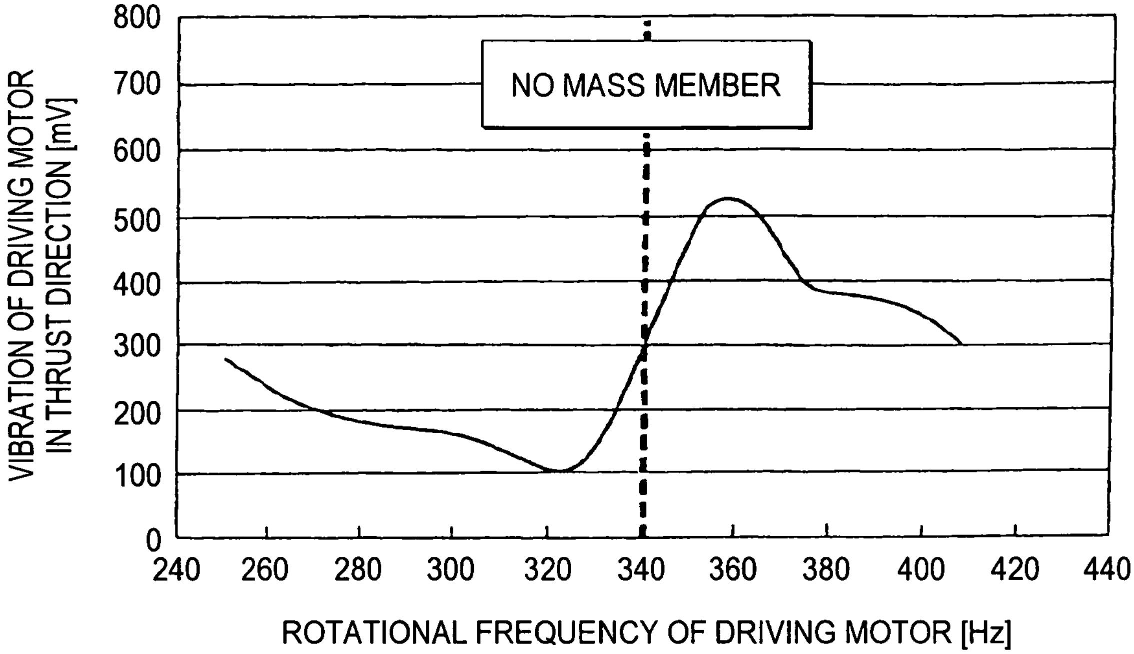

NO MASS MEMBER
VIBRATION OF DRIVING MOTOR IN THRUST DIRECTION [mV]
800
700
600
500
400
300
200
100
0
240 260 280 300 320 340 360 380 400 420 440
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

FIG. 7

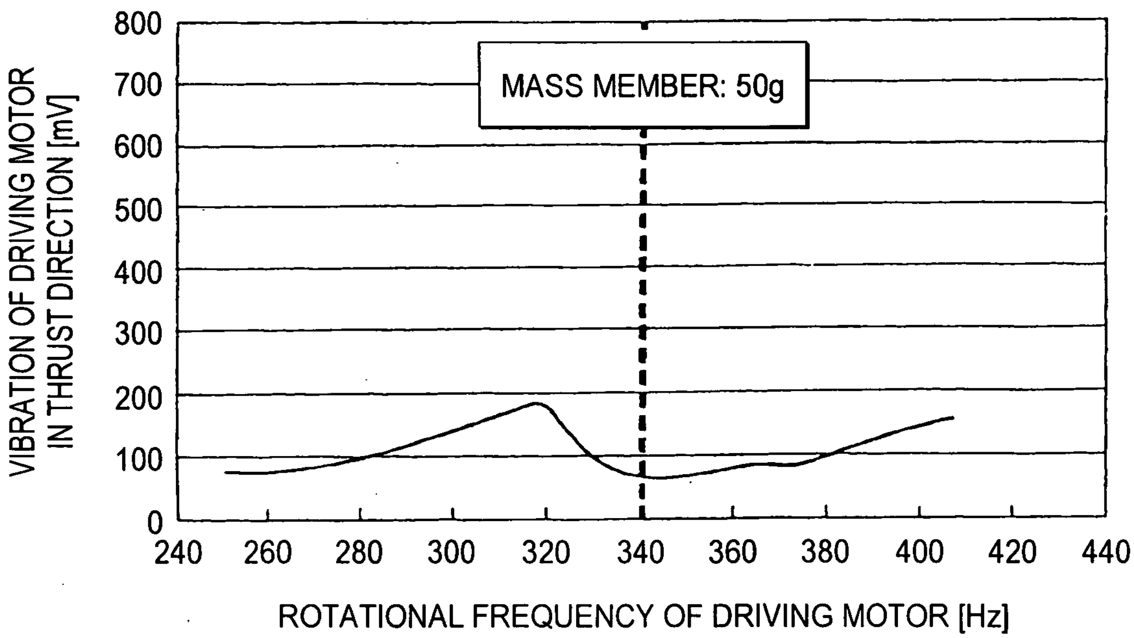

MASS MEMBER: 50g
VIBRATION OF DRIVING MOTOR IN THRUST DIRECTION [mV]
800
700
600
500
400
300
200
100
0
240 260 280 300 320 340 360 380 400 420 440
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

FIG. 8

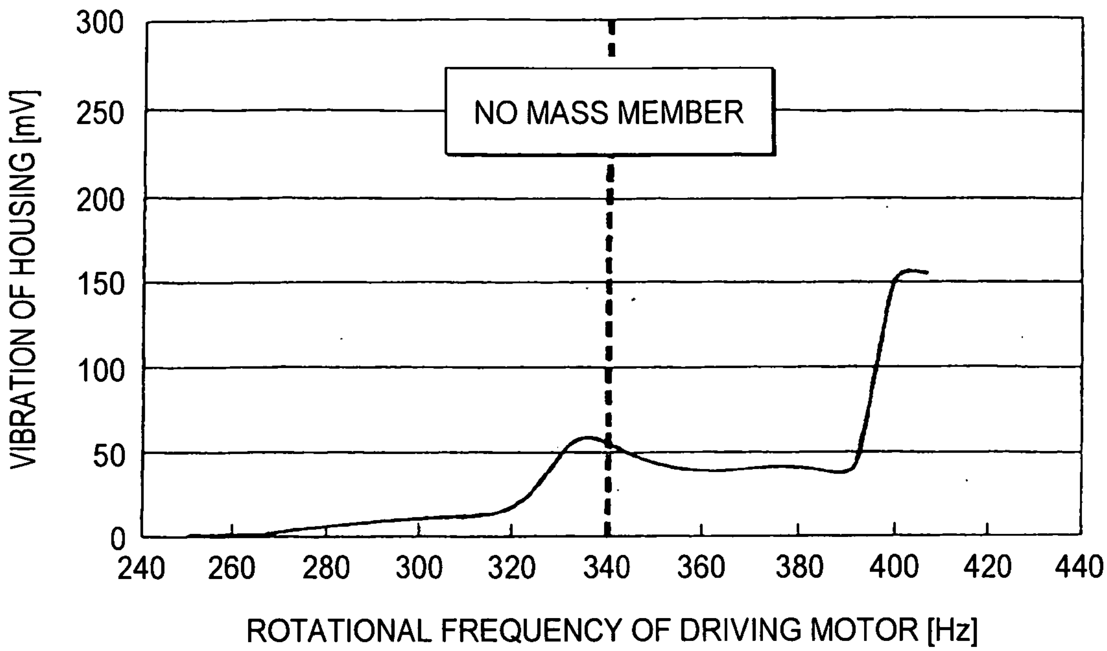

300
250
200
150
100
50
0
VIBRATION OF HOUSING [mV]
NO MASS MEMBER
240
260
280
300
320
340
360
380
400
420
440
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

FIG. 9

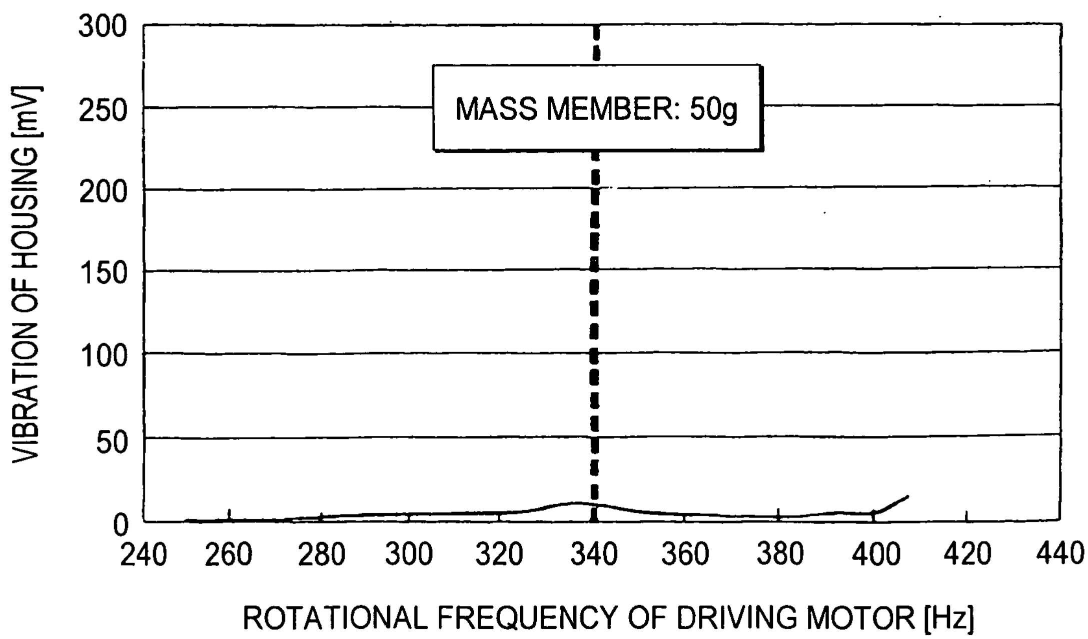

300
250
200
150
100
50
0
VIBRATION OF HOUSING [mV]
MASS MEMBER: 50g
240
260
280
300
320
340
360
380
400
420
440
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

FIG. 10

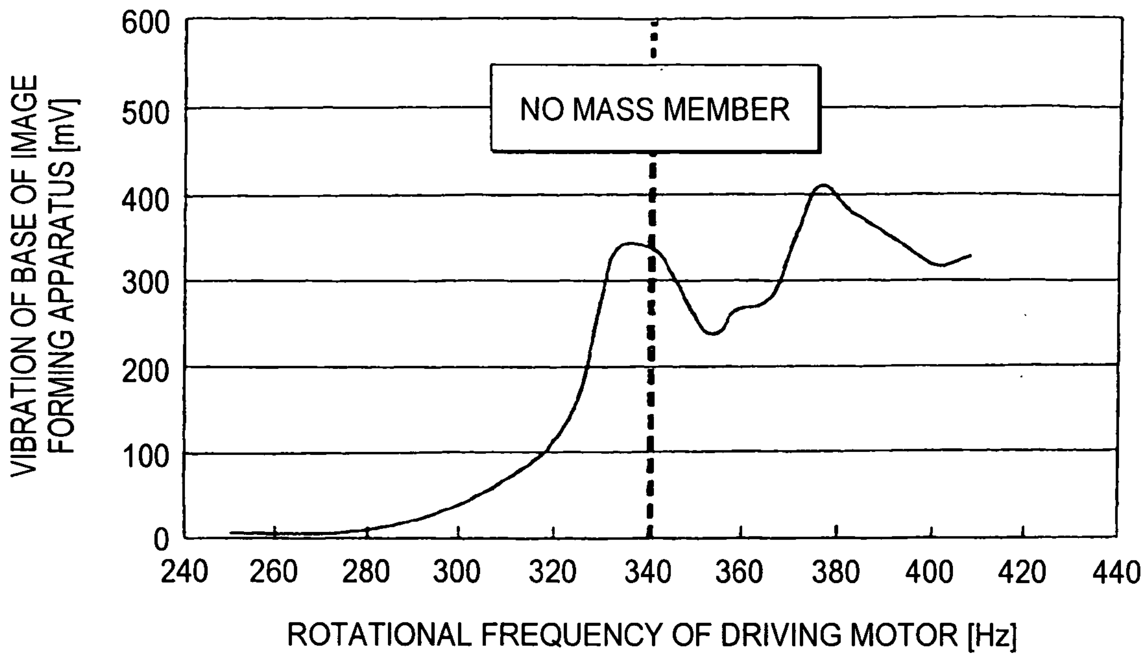

600
500
400
300
200
100
0
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
NO MASS MEMBER
240
260
280
300
320
340
360
380
400
420
440
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

FIG. 11

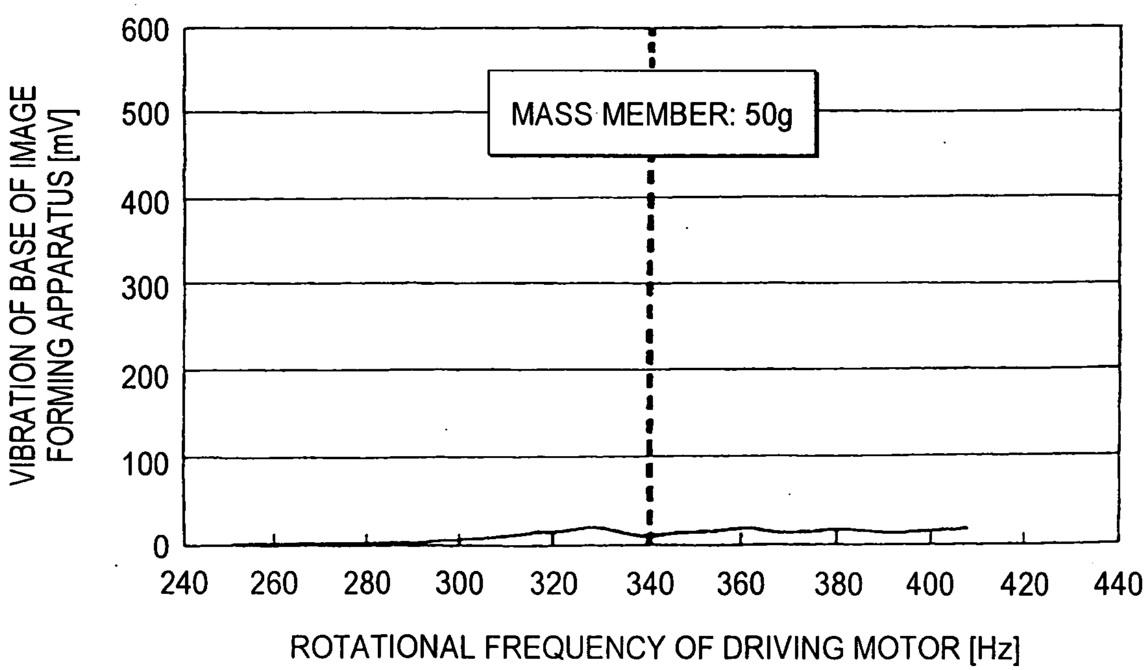

600
500
400
300
200
100
0
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
MASS MEMBER: 50g
240
260
280
300
320
340
360
380
400
420
440
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

FIG. 12

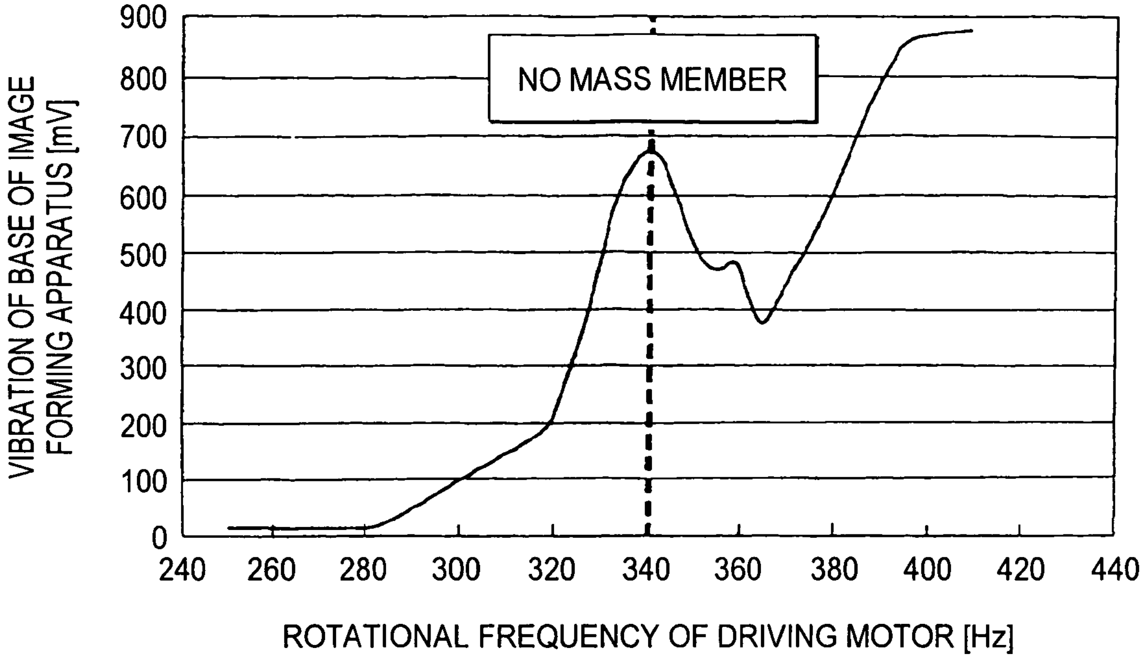

NO MASS MEMBER
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
0
100
200
300
400
500
600
700
800
900
240
260
280
300
320
340
360
380
400
420
440
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

FIG. 13

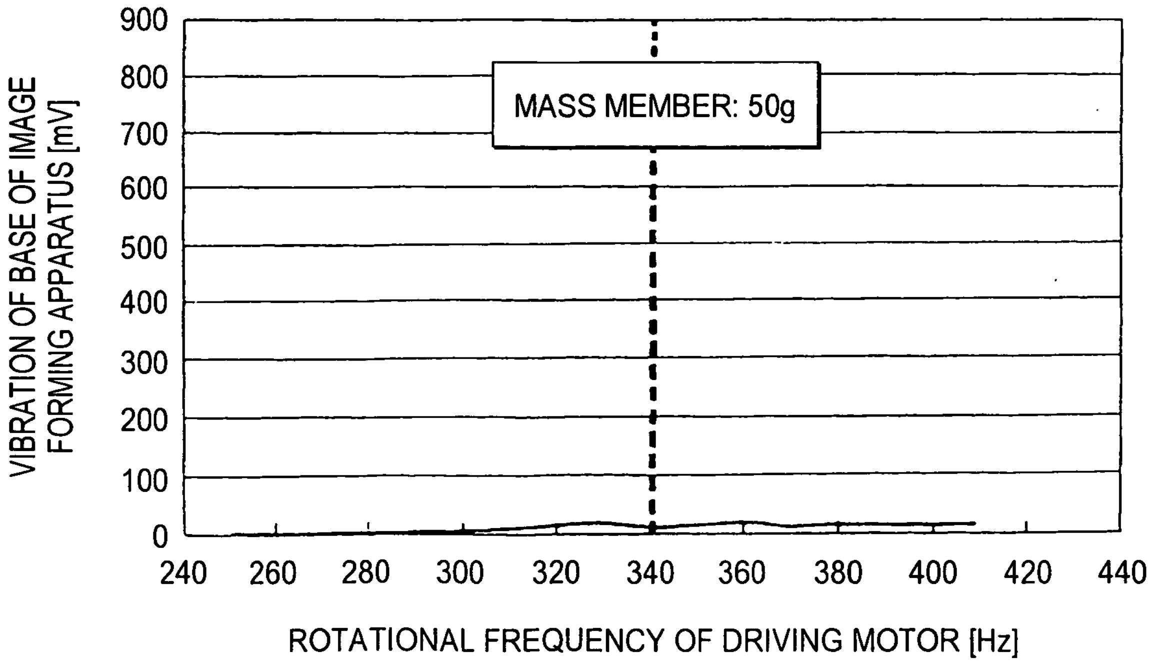
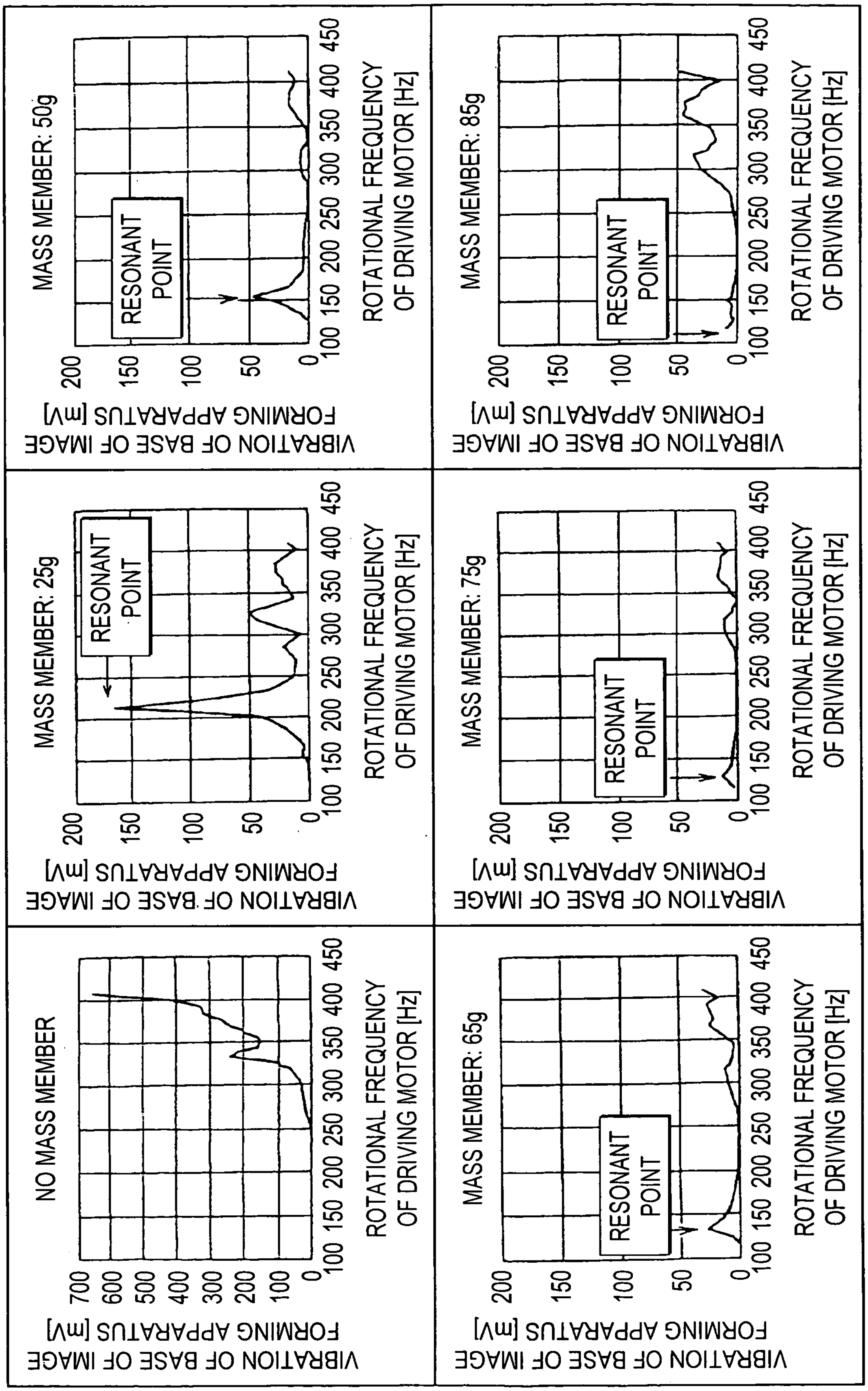

MASS MEMBER: 50g
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
0
100
200
300
400
500
600
700
800
900
240
260
280
300
320
340
360
380
400
420
440
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

FIG. 14



(A)
NO MASS MEMBER
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
700 600 500 400 300 200 100 0
100 150 200 250 300 350 400 450
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]
(B)
MASS MEMBER: 25g
RESONANT POINT
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
200 150 100 50 0
100 150 200 250 300 350 400 450
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]
(C)
MASS MEMBER: 50g
RESONANT POINT
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
200 150 100 50 0
100 150 200 250 300 350 400 450
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]
(D)
MASS MEMBER: 65g
RESONANT POINT
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
200 150 100 50 0
100 150 200 250 300 350 400 450
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]
(E)
MASS MEMBER: 75g
RESONANT POINT
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
200 150 100 50 0
100 150 200 250 300 350 400 450
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]
(F)
MASS MEMBER: 85g
RESONANT POINT
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
200 150 100 50 0
100 150 200 250 300 350 400 450
ROTATIONAL FREQUENCY OF DRIVING MOTOR [Hz]

FIG. 15

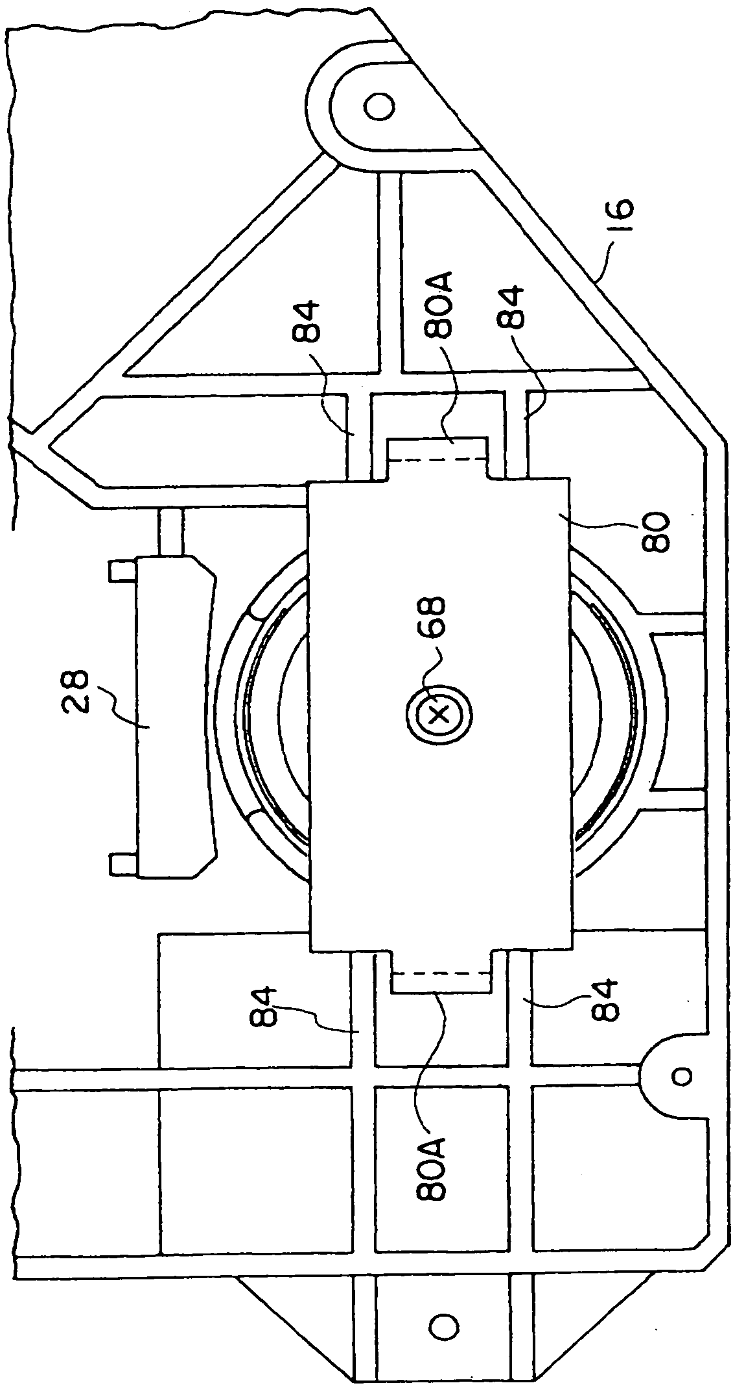


FIG. 16

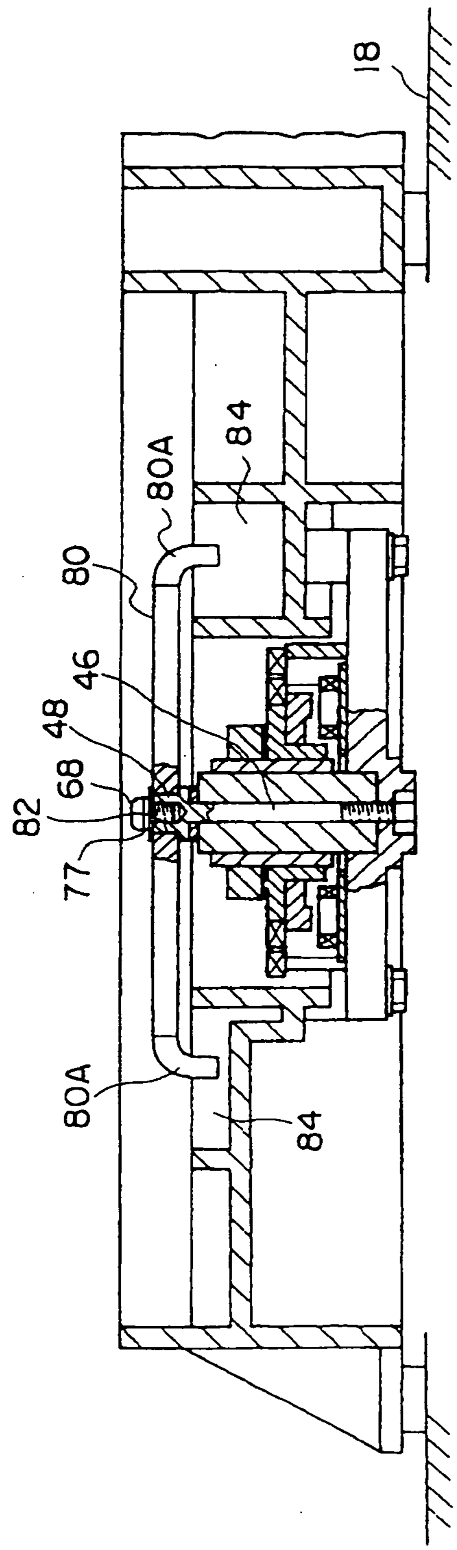
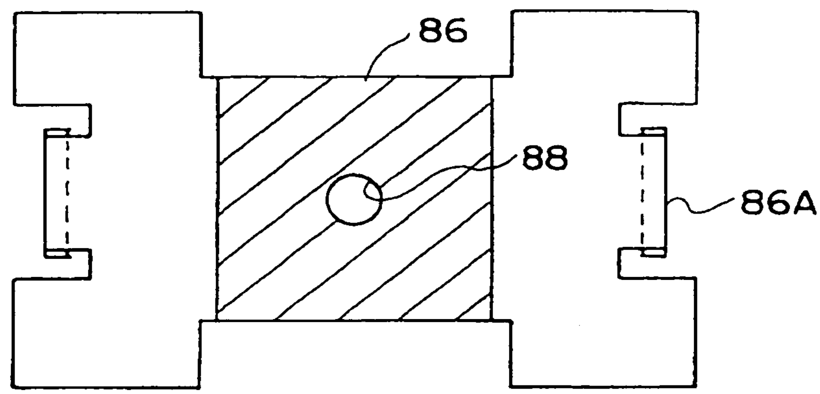


FIG. 17

(A)



(B)

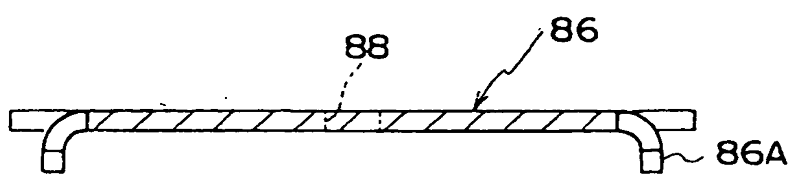
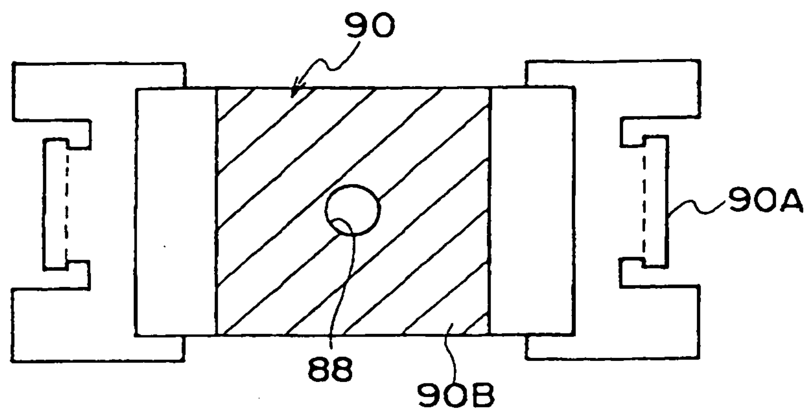


FIG. 18

(A)



(B)

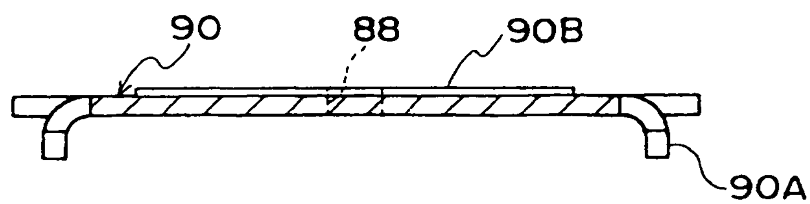
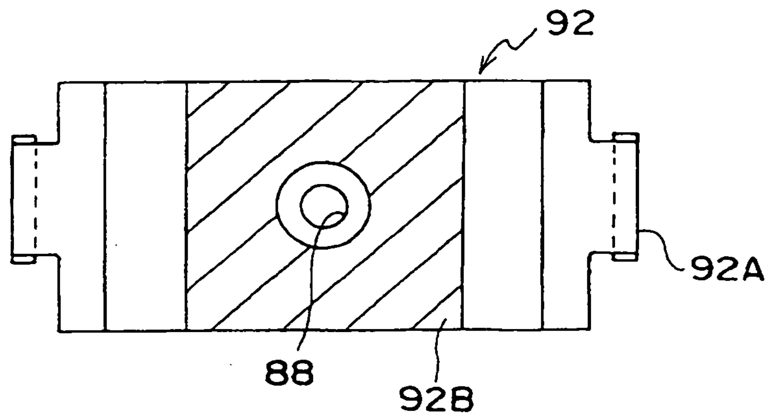


FIG. 19

(A)



(B)

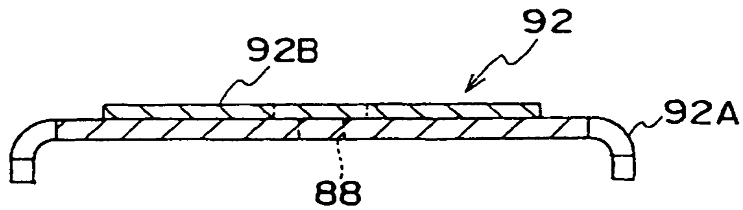


FIG. 20

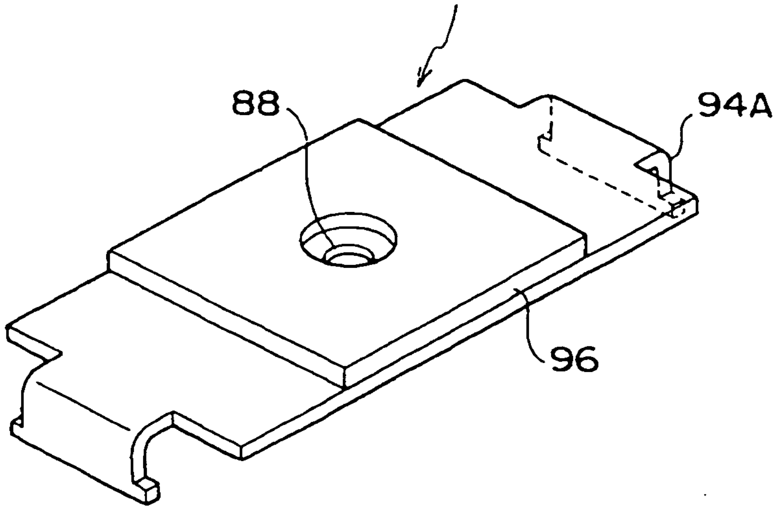
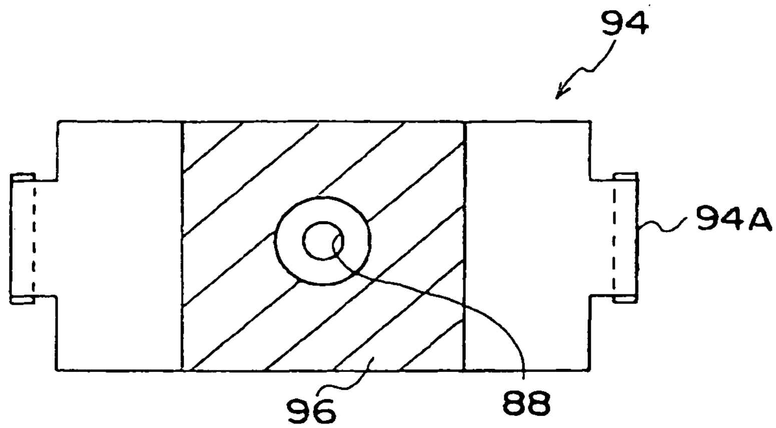


FIG. 21

(A)



(B)

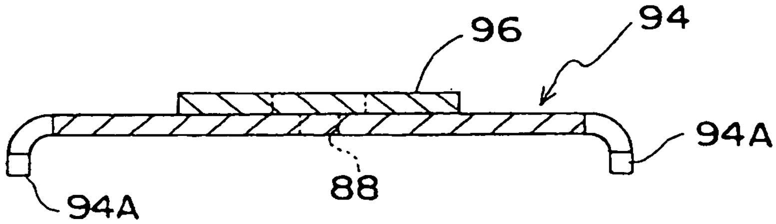


FIG. 22

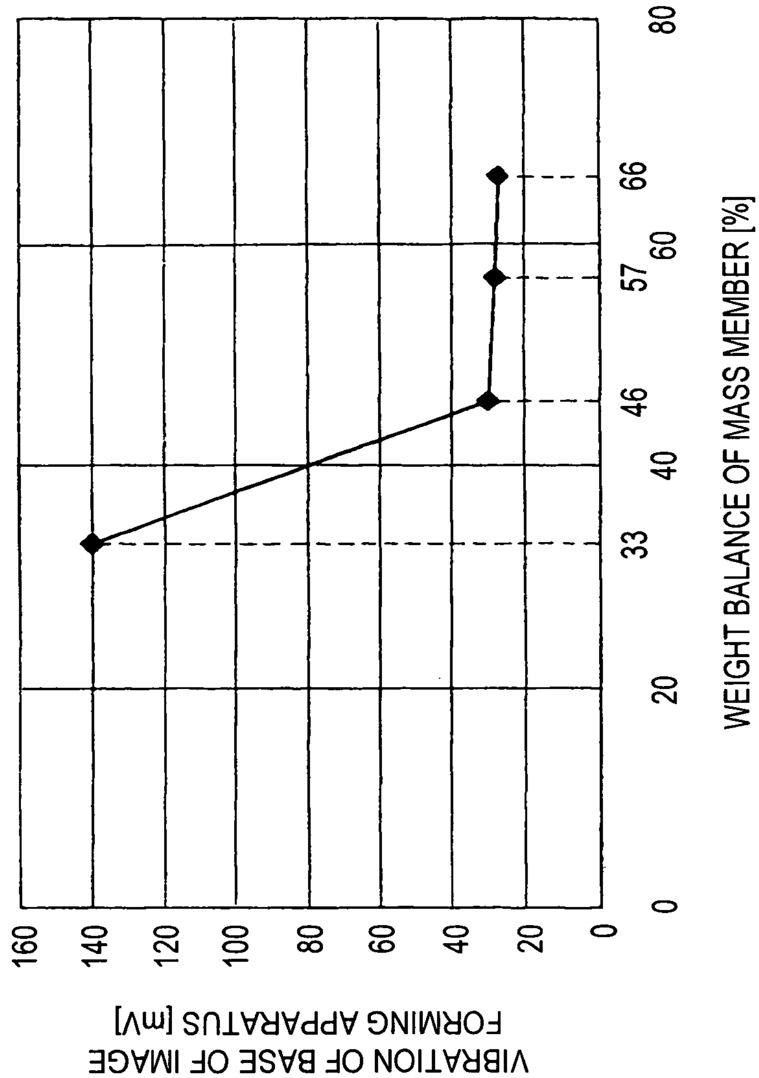

0
20
40
60
80
100
120
140
160
VIBRATION OF BASE OF IMAGE FORMING APPARATUS [mV]
0
20
33
40
46
57
60
66
80
WEIGHT BALANCE OF MASS MEMBER [%]

FIG. 23

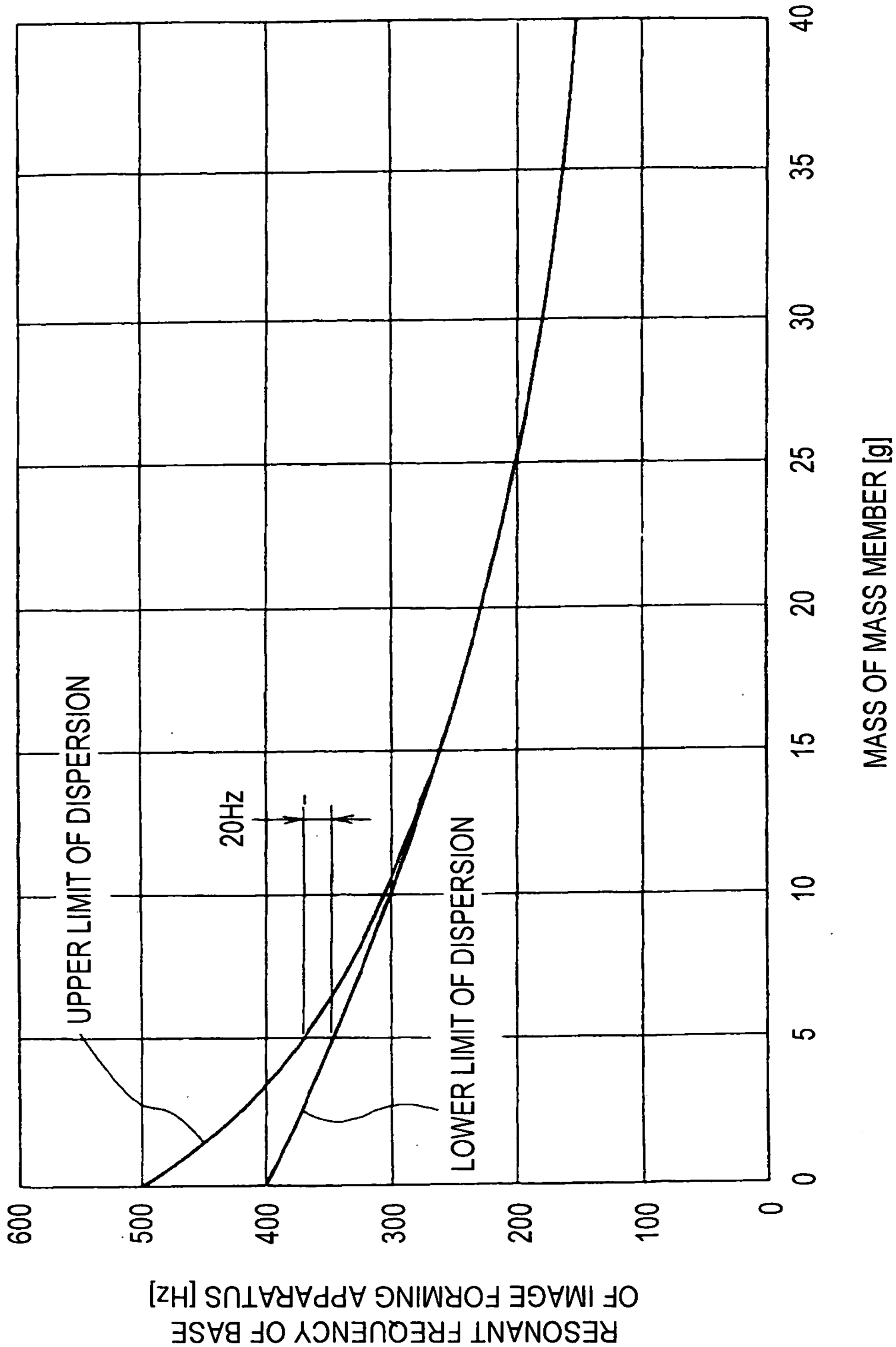

RESONANT FREQUENCY OF BASE OF IMAGE FORMING APPARATUS [Hz]
0
100
200
300
400
500
600
MASS OF MASS MEMBER [g]
0
5
10
15
20
25
30
35
40
UPPER LIMIT OF DISPERSION
LOWER LIMIT OF DISPERSION
20Hz

FIG. 24

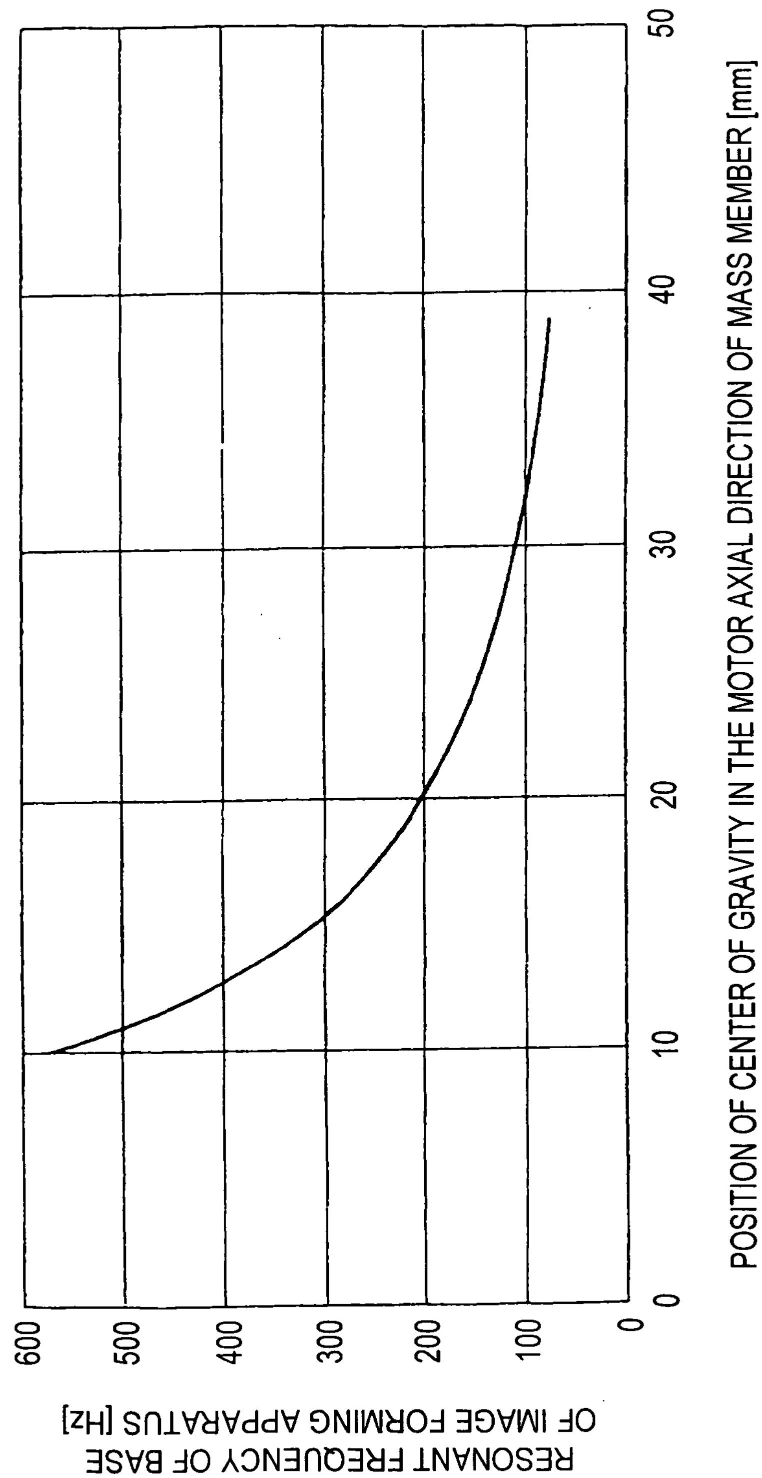

POSITION OF CENTER OF GRAVITY IN THE MOTOR AXIAL DIRECTION OF MASS MEMBER [mm]
0
10
20
30
40
50
RESONANT FREQUENCY OF BASE OF IMAGE FORMING APPARATUS [Hz]
0
100
200
300
400
500
600

FIG. 25

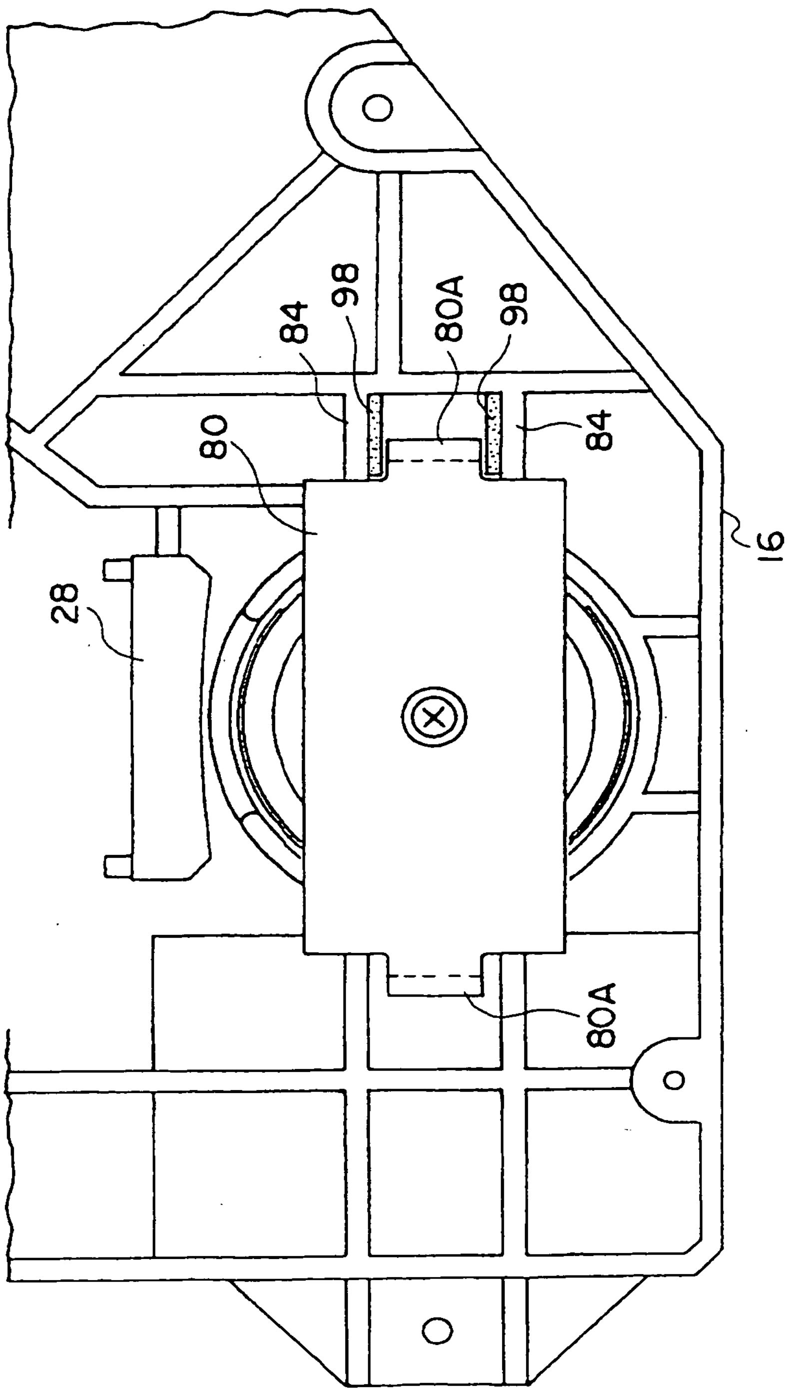


FIG. 26

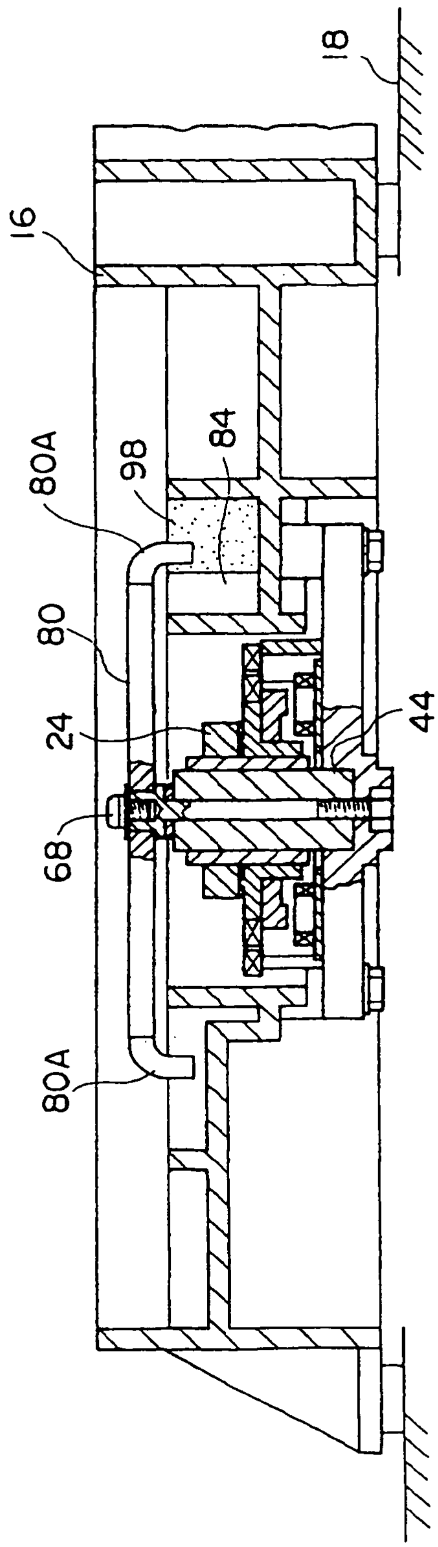


FIG. 27

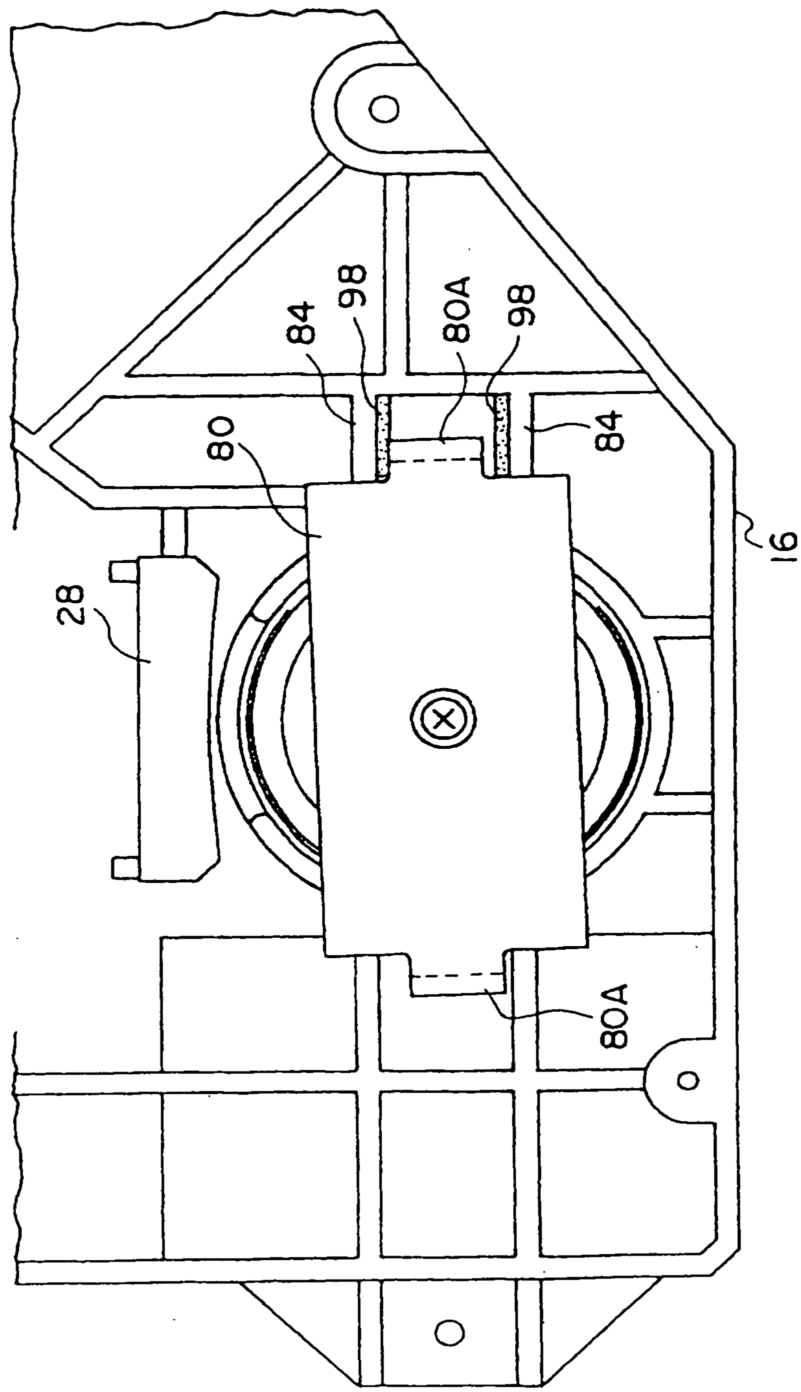


FIG. 28

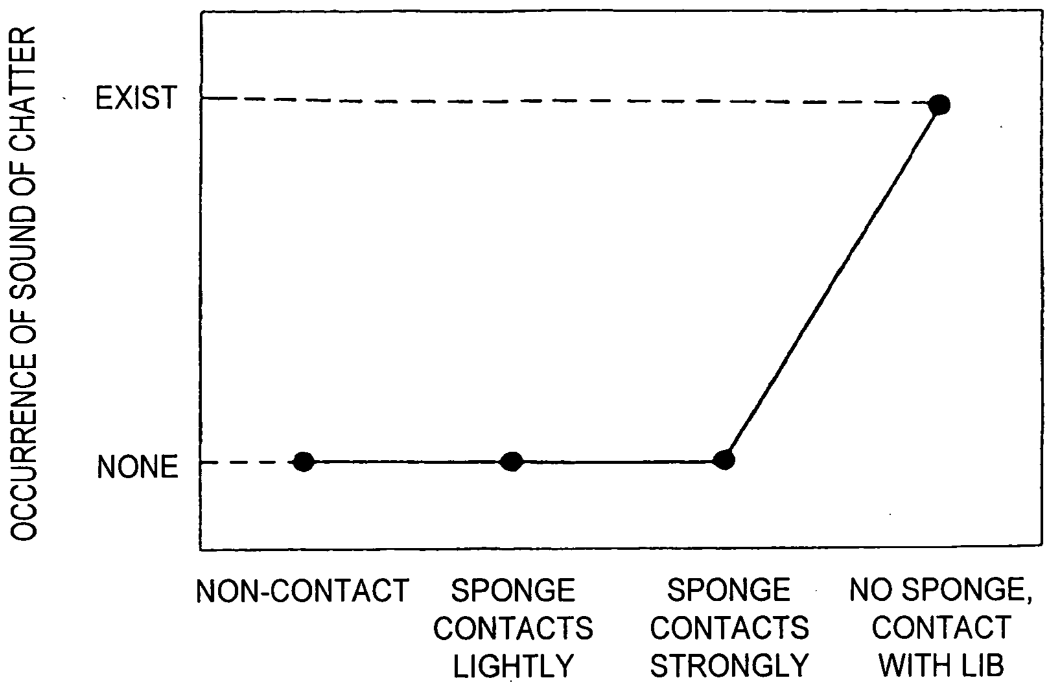

OCCURRENCE OF SOUND OF CHATTER
EXIST
NONE
NON-CONTACT
SPONGE CONTACTS LIGHTLY
SPONGE CONTACTS STRONGLY
NO SPONGE, CONTACT WITH LIB

FIG. 29

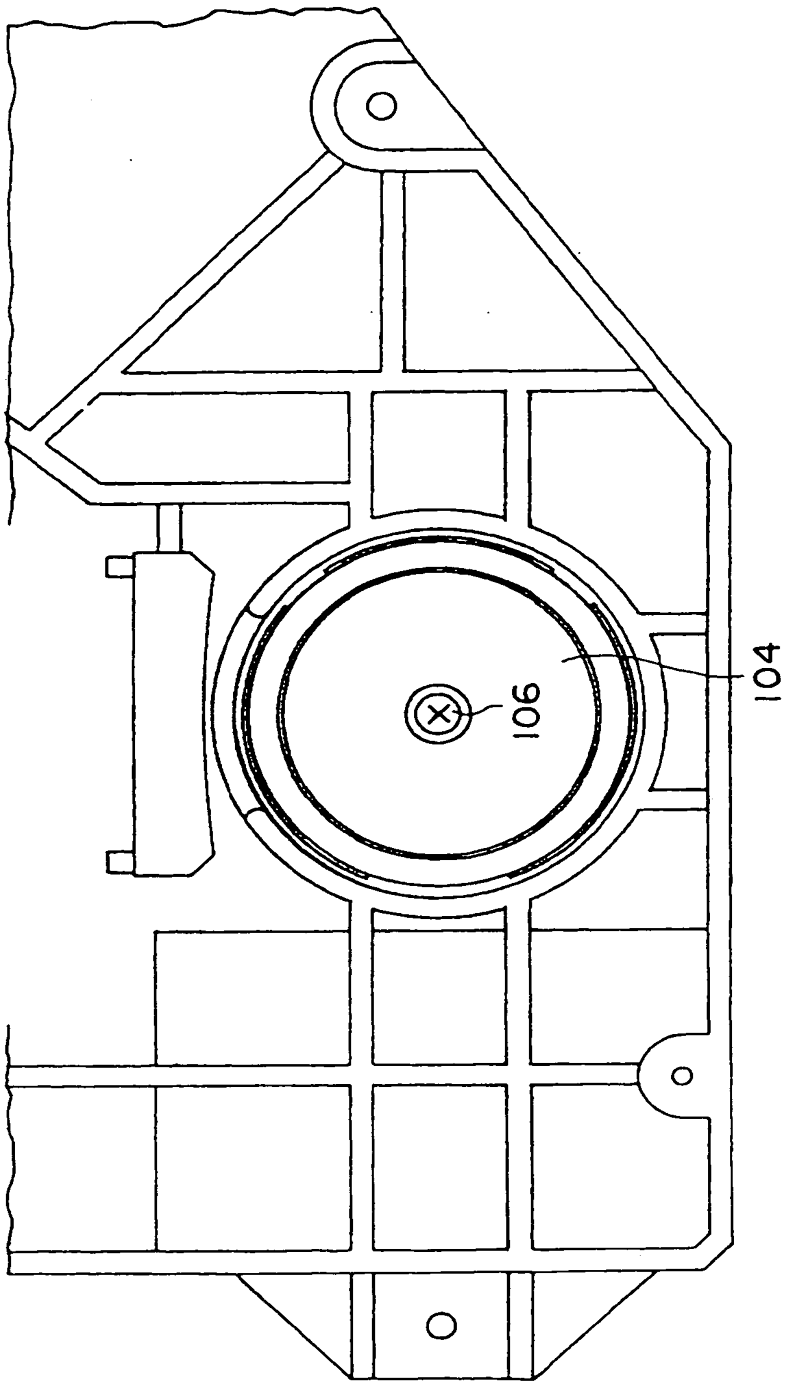


FIG. 30